

Allergic responses to pollen of ornamental plants: High incidence in the general atopic population and especially among flower growers

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Background: The incidence of allergy to pollen of ornamental plants has not been deeply investigated, and its extent has remained obscure. Most of such studies have concentrated only on pollen of ornamental plants from the Asteraceae family (Compositae). In this study an attempt was made to clarify whether various other ornamental plants may also cause skin responses and allergic symptoms among allergic urban dwellers and among rural flower growers.

Methods: Two hundred ninety-two patients were referred for allergic evaluation by their primary physicians; 75 flower growers and 44 university students were evaluated. For all participants, a detailed health record was obtained, and skin prick tests (SPTs) were performed. Extracts for SPTs included commercial common airborne allergens and autochthonous pollen extracts of 11 species of plants belonging to the Asteraceae, Ranunculaceae, Liliaceae, Scrophulariaceae, and Genetianaceae families.

Results: Fifty-one of the 292 patients (17%) referred for allergic evaluation had positive SPT responses to pollen of various ornamental plants. A similar incidence was found among the students (23%). However, the incidence among flower growers was significantly higher, reaching 52%. Higher incidence (83%) of positive SPT responses to ornamental plants was found among flower growers also sensitive to the common allergens. All the tested plants, not only those belonging to the Asteraceae family, provoked positive SPT responses in all 3 groups of participants. None of the participants from the general population or the group of students reported exacerbation of allergic symptoms on exposure to the tested plants. In contrast, almost half of the flower growers (45%) described nasal, ocular, or respiratory symptoms associated with occupational exposure to the tested plants. Some 15% of the growers were eventually compelled to change their profession.

Conclusions: The incidence of positive SPT responses to ornamental plants was 17% to 23% among the general public but 52% among flower growers. Thus the effects of ornamental plant pollen on atopic patients should be seriously contemplated. (*J Allergy Clin Immunol* 1998;102:•••.)

Key words: Ornamental plants, pollen, flowers, flower growers, atopy

Abbreviation used

SPT: Skin prick test

Exposure to pollen of ornamental plants is routinely experienced by most people. The extent of possible adverse effects induced by an exposure to such flowers is unknown. Allergic symptoms resulting from exposure to ornamental plants may be caused either by primary sensitization to pollen of such plants or from cross-reactivity with pollen of their wild relatives. The following study was conducted with the aim to elucidate the incidence of positive skin prick tests (SPTs) to some of the most common flowers in a general population referred for allergic evaluation, in a group of student volunteers, and in a group of flower growers. The latter represent a population with occupational exposure to such plants. We also aimed to establish the clinical relevance of positive SPT responses to pollen of the examined flowers as reflected by their association with clinical exacerbation inflicted on exposure.

METHODS

The study population included 411 participants and was composed of three groups. The first group constituted 292 patients who were referred by their primary physicians for allergic evaluation in the allergy unit of our hospital. These patients represent an urban population, with only a few of them coming from a rural area. Most of the patients (96%) were referred with an initial suspected diagnosis of chronic rhinitis, asthma, or both. Six patients were referred for urticaria, 4 had atopic dermatitis or other chronic skin rashes, and 3 others had other disturbances. The second group included flower growers from nearby rural areas living in 3 villages. One hundred five active commercial flower growers were asked to participate in the study. Seventy-five of them (71%) showed up at the local health center for examination. They have been involved in flower growing for various periods ranging from 1 to 30 years. During those years they had been exposed to a variety of flowers for various periods of time. The third group consisted of 44 first-year students of biology at Tel-Aviv University. The demographic data are presented in Table I.

A detailed medical history was taken from each of the participants, with emphasis placed on the following allergic symptoms: chronic or chronically relapsing rhinitis or conjunctivitis, asthma, and skin eruptions. The participants were specifically asked about association between exposure to ornamental plants and exacerbation of nasal, ocular, respiratory, or dermal symptoms. Seven additional growers, inhabitants of other villages, were also tested. These growers had been growing *Solidago* and *Solidaster* plants for various periods of time, until they had to stop growing these plants because of the appearance of severe allergic symptoms. The characteristics of these 7 growers are reported separately.

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TABLE I. Demographic data

	No. of patients	M/F	Mean age, yrs (range)
Patients referred for allergic evaluation	292	142/150	31 (7-76)
Flower growers	75	57/18	46 (11-76)
Biology students	44	16/28	23 (18-33)

Extracts for SPTs with the commercial common airborne allergens included *Dermatophagoides farinae*, *D. pteronyssinus*, cat hair and cat pelt, dog pelt, American cockroach, mixed molds (*Alternaria*, *Hormodendrum*, *Aspergillus*, and *Penicillium* species), and the following pollen: (1) trees (cypress [*Cupressus sempervirens*], olive [*Olea europaea*], and pecan nut [*Carya illinoensis*]); (2) grasses (Bermuda [*Cynodon dactylon*], orchard [*Dactylis glomerata*], rye [*Lolium* species], and Johnson [*Sorghum halepense*]); and (3) weeds [Lamb's quarter [*Chenopodium album*], pigweed [*Amaranthus* species], English plantain [*Plantago lanceolata*], sagebrush [*Artemisia* species], and Russian thistle [*Salsola kali*]]. All extracts were made by Center Laboratories (Port Washington, N.Y.).

Pollen grains of the additional plant species were collected by vacuum suction directly from the inflorescences. The sifted pollen grains were sonicated in an ice-cold, sterile, saline-glycerol buffer solution at pH 8.2, containing 2.8% NaHCO₃, 0.5% NaCl, and 50% glycerol (ie, the standard solution in which commercial allergen extracts were supplied). The solution was then centrifuged for 30 minutes at 7600 *g* to allow precipitation of the pollen-grain solid remains. The supernatant was then filtered through a membrane with 45- μ m diameter pores. The protein content of the obtained extract was determined by the Lowry procedure, with BSA as a standard.¹ After the protein content was determined, each of the autochthonous extracts was diluted to a standard concentration of 4 mg protein/ml solution. The extracts were not dialyzed before use. These allergen extracts were then stored frozen. Details of the preparation procedure have been described previously by Waisel et al.²

The ornamental flowers that were tested included the following: (1) members of the Asteraceae (Compositae) family (*Chrysanthemum coronarium*, *Helianthus annuus* [Sunflower], *Gerbera jamesonii*, *Senecio vernalis*, *Solidago canadensis* [Gold-erod], *Solidaster* [a cross between *Solidago* and *Aster*], and *Verbesina encelioides*); (2) a member of the Ranunculaceae family (*Anemone coronaria*); (3) a member of the Lililaceae family (*Lilium longiflorum* [Lily]); (4) a member of the Scrophulariaceae family (*Antirrhinum majus* [Snap dragon]); (5) and a member of the Gentianaceae family (*Lisianthus grandiflorum*).

The data was statistically analyzed with the chi-square test for intergroup comparisons. This investigation was approved by the institutional ethical committee.

RESULTS

Positive SPT responses to pollen of the tested flowers gave similar percentages among patients referred for allergic evaluation and among the students. The frequency of positive SPT responses among the growers was significantly higher than that for the other groups (Table II). The incidence of positive SPT responses to other allergens was equal in all 3 groups. Fifty-one patients (17%) of the group referred for allergic evaluation had positive SPT responses to the pollen of the ornamental plants. Only 2 of these patients (4%) had positive SPT responses to the pollen of the tested flow-

ers without having positive SPT responses to the other common allergens. However, the occurrence of positive SPT responses to flower pollen, together with negative SPT responses to common airborne allergens, was significantly more common among the growers as compared with the patients referred for allergic evaluation. When considering as atopic any participant having at least 1 positive SPT response to a common airborne allergen, the prevalence of positive SPT responses to ornamental plants was also significantly higher among the flower growers (Table III). The number of patients reporting chronic rhinitis, asthma, or both among the patients referred for allergic evaluation was significantly larger than their number in the other 2 groups (Table IV). When only patients with allergic symptomatology were counted, the incidence of positive SPT responses to the common allergens was similar for all 3 groups. However, when patients with allergic symptoms were compared with regard to positive SPT responses to ornamental flower pollen, the incidence among the flower growers was again significantly higher. None of the patients referred for allergic evaluation and none of the students reported any specific responses or allergic exacerbation on exposure to the tested flowers. Thirty-four growers (45% of the population) reported having respiratory, nasal, or ocular symptoms after work in their greenhouses. Cutaneous irritation or rashes inflicted by contact with the plants' leaves, which were also reported by some growers, were not included. Sixteen of the flower growers with nasal or respiratory symptoms (47%) had positive SPT responses to the common airborne allergens, and a similar number had positive SPT responses to the ornamental flower pollen. Four growers, exhibiting positive SPT responses to a specific ornamental plant, reported clinical exacerbation on exposure to that species.

A subgroup of 7 flower growers reported recurrent disturbing nasal, ocular, or respiratory symptoms within minutes after exposure to *Solidaster* plants. Five of these growers had positive SPT responses to *Solidaster* plants. One flower grower had a positive SPT only to *Verbesina* species (a wild plant that belongs to the Asteraceae family), and 1 flower grower had no positive SPT responses to either of the tested flowers. Three flower growers showed positive SPT responses to pollen of additional families of flowers. All 7 growers abandoned growing flowers and changed their occupation. As reported by the Ministry of Agriculture, this subgroup represents as much as 15% of the growers who were involved in growing *Solidaster* plants. One flower grower of this study group, who had a positive SPT response to *Gerbera* pollen and clinical exacerbation when exposed to this plant, avoided growing this species but continued to grow other flowers.

SPT responses to flowers of various families are presented in Table V. Apparently, positive reactions to pollen of the Asteraceae family were most frequent, and over 90% of the participants who had at least one positive SPT response to pollen of the tested flowers had a positive SPT response to pollen of plants of this family. All other pollen

TABLE II. SPT results of all participants

	Positive SPT response to common allergens	Positive SPT response to ornamental plants	Positive SPT responses to pollen in patients exhibiting negative SPT responses to common allergens (percentage of positive SPT responses to flowers)
Patients referred for allergic evaluation (n = 292)	192 (69%)	51 (17%)*	2 (4%)†
Flower growers (n = 75)	47 (63%)	39 (52%)*‡	7 (18%)†
Biology students (n = 44)	23 (52%)	10 (23%)*‡	1 (10%)

*P < .0001.

†P < .01.

‡P < .005.

TABLE III. SPT results of the atopic participants

	Total no.	Positive SPT response to flower pollen
Patients referred for allergic evaluation	192	51 (27%)*
Flower growers	47	39 (83%)*†
Biology students	23	10 (43%)*†

*P < .0001.

†P < .001.

from the other 4 families of ornamental plants also induced positive SPT responses, although to a lesser degree. The effects of the pollen of the various families on positive SPT responses did not differ in the 3 study groups.

DISCUSSION

Common airborne allergens, both perennial and seasonal, are the most frequent triggers for allergic sensitization and clinical symptomatology. The recurrent and heavy exposure to such allergens is one of the factors that contributes to the development of clinical symptoms in people with a genetic tendency for atopy. Exposure to pollen of ornamental plants was believed to be much less common in the general population but can be rather excessive among growers of these plants. IgE-mediated reactions could be attributed either to mucosal exposure to such pollen^{3,4} or to other parts of the plant, such as the leaves of *Ficus benjamina*.^{5,6} Similarly, a reaction of allergic contact dermatitis in which the sensitizing factors are lactones was described for various plants of the Asteraceae family,⁷ specifically for *Parthenium*⁸ and for *Urtica*⁹ species, with a presumed cell-mediated mechanism. The prevalence of positive SPT responses to Asteraceae in atopic populations ranged from 19% to 43%.¹⁰ Provocation tests conducted with selected patients who have asthma or rhinitis and have positive SPT responses to different pollen of the Asteraceae family elicited positive responses in all patients.^{3,10}

Previous descriptions of allergic reactions to various flowers were limited either to case reports¹¹⁻¹³ or to a single plant species in a region-based selected population.^{3,10} Our study is unique regarding both the size and the geographic distribution of the investigated population, as well

as the large number and variety of the ornamental flowers that were tested. Nevertheless, the prevalence of positive SPT responses to pollen extracts in the general atopic population of our study (18%) is similar to the incidence found by Kuroume et al.¹⁰ (19%), although their population originated from the Japanese mountain districts, where growing of *Chrysanthemum* species is rather extensive.

Positive SPT responses to ornamental flowers were significantly more common among commercial flower growers as compared with the other 2 groups investigated. This was also true when only atopic patients with positive SPT responses to the common allergens were studied or when only patients with a history of chronic rhinitis or asthma were compared (Tables II, III, and IV). Such findings emphasize, once again, the role that is played by exposure to a potential allergenic trigger in the sensitization of subjects to that allergen.

The clinical relevance of positive SPT responses to pollen of ornamental flowers is not clear. None of the patients referred for allergic evaluation were aware of any adverse effects inflicted by the flowers. This may be partially explained by the lack of public awareness of the possible role of such flowers in the induction of allergy. This differed in the case of the flower growers, with almost half of them reporting nasal, ocular, or respiratory symptoms on exposure to such pollen. This was proven also by bronchial or ocular challenges with such pollen, which were done by other investigators.^{3,10} Challenging our entire study population would have been desirable but was not approved because of ethical reasons.

As a rule, in all 3 groups of patients, positive SPT responses to the tested pollen were more common among patients having positive SPT responses to other allergens (Tables II and III). This was highly conspicuous for the group of flower growers in whom positive SPT responses to ornamental plant extracts were 2 to 3 times more common among individuals having positive SPT responses also to the common allergens than among patients of the other 2 groups. Cutaneous sensitization, demonstrated by a positive SPT response, might have been initiated by primary exposure to the tested flowers. A clue for the role of such plants as primary sensitizing agents can be found in the 8% of flower growers who had positive SPT responses to the flowers without having any other positive SPT responses to all other allergens. However, sensitization to

TABLE IV. SPT results of participants with a history of chronic rhinitis, asthma, or both

	No. of patients with rhinitis/ asthma (% of all)	Positive SPT responses to common allergens (% of patients with rhinitis/asthma)	Positive SPT responses to flowers (% of patients with rhinitis asthma)
All patients	279 (96%)	190 (68%)	51 (18%)*
referred for allergic evaluation (<i>n</i> = 292)			
All flower growers (<i>n</i> = 75)	29 (39%)	16 (55%)	11 (38%)*
All biology students (<i>n</i> = 44)	12 (27%)	9 (75%)	2 (17%)

P* < .02.TABLE V.** Distribution of positive SPT responses to pollen extracts from members of 5 families of ornamental plants

Patients with at least 1 positive SPT response to ornamental plants	Asteraceae	Ranunculaceae	Liliaceae	Scrophulariaceae	Gentianaceae
Patients referred for allergic evaluation (<i>n</i> = 51)	50 (98%)	9 (18%)	11 (22%)	17 (33%)	11 (22%)
Flower growers (<i>n</i> = 39)	36 (92%)	5 (13%)	7 (18%)	9 (23%)	7 (18%)
Biology students (<i>n</i> = 10)	9 (90%)	1 (10%)	2 (20%)	2 (20%)	1 (10%)

ornamental plants might also indicate cross-sensitization between these plants and other common allergens, which could have been the real sensitizing agents. The mechanism is probably composed of both the atopic tendency and the degree of exposure of each individual.

The group of students who volunteered to participate in the study included healthy people but also people who suspected that they might have some kind of allergic symptoms, which they wanted to check. Indeed, 52% of them had positive SPT responses to the common allergens, and 75% reported rhinitis, asthma, or both in the past. These ratios are similar or even larger than the ratios in the other 2 groups. Therefore this group should not be considered as a true control group representing a general healthy population. Rather, they may represent a population with self-beliefs of having allergy.

The aim of our study was to examine the impact of atopic tendency and of heavy exposure on the development of skin reactivity to pollen of ornamental plants. Therefore we have concentrated on a population of referred patients and on flower growers. A comparison with an unselected general population would have been desirable but could not be accomplished. Nevertheless, the significance of ornamental flowers to the population at risk is well demonstrated in our investigation.

Pollen of all 5 families of plants may induce positive SPT responses. Over 90% of these positive responses from all 3 patient groups were induced by pollen of members of the Asteraceae family. The contribution of pollen of the Asteraceae family is above their share among the studied flowers (7 of 11 species, 64%). Taking into account the fact that cross-reactivity exists between different members of the Asteraceae family,⁴ the relative contribution of this family to positive SPT responses to the tested plants was much larger than

expected. The frequent positive SPT responses to plants of the Asteraceae family do not seem to result from an irritant effect. This is proven by the fact that more than 80% of the subjects did not have such responses. Several explanations can therefore be suggested. First, as previously discussed, the primary sensitization to ornamental plants is caused by pollen of wild plants. Because plants of the Asteraceae family are much more common than those of the other 4 tested families, it is reasonable to find a higher incidence of positive SPT responses to pollen of the Asteraceae family. An alternative explanation is that the allergenicity of such pollen is stronger than that of other flowers. An additional reason might be the popularity of composite flowers among flower buyers, which leads to a higher exposure to such pollen. Though none of the suggested explanations was checked, we suggest that a combination of all 3 factors is probably responsible for the high cutaneous sensitization to plants of the Asteraceae family. The role of the other ornamental plants is described here for the first time.

High occupational exposure to pollen associated with unbearable allergic symptoms resulted in the necessity of some 15% of the flower growers to abandon their occupation. Similar results can be expected in the general population on exposure to various flowers. Anecdotal reports of such episodes after offering flowers to a spouse are occasionally heard by many practicing allergists.

We conclude that nonoccupational exposure and sensitization to ornamental plants is rather common in the general population. Skin testing with pollen extracts of various common flowers, especially those of the Asteraceae family, should routinely be performed when airborne allergy is suspected, especially for patients with

high occupational exposure to ornamental plants. Currently, no commercial extracts are available for many of the ornamental species. Therefore it is difficult to get figures for a large population. However, we do hope that the results of this investigation will incite pharmaceutical companies to add pollen extracts of such plants to their inventory of plant allergens.

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Correction

The following correction applies to the article by Plebani et al entitled "Engrafted maternal T cells in human severe combined immunodeficiency: Evidence for a T_{H2} phenotype and a potential role of apoptosis on the restriction of T-cell receptor variable β repertoire," which appeared in volume 101, number 1, part 1, pp. 131-134, 1998, of The Journal.

One of the authors' names was misspelled in the author line. The name that reads "Ignazia Priglione, PhD" should read "Ignazia Prigione, PhD."